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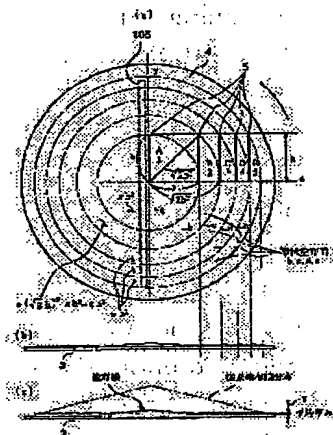
(72)Inventor : HARUKAWA SUMIO

## (54) ROTARY COATING DEVICE

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To coat with the small quantity of a coating liquid without forming a primary coating film into a round shape at the central part of a rotating base plate or an non-uniform state, which exerts large influence on a secondary coating film, at the time of forming the secondary coating film by the centrifugal force generated by high speed rotation after forming the primary coating film using a coating head.

**SOLUTION:** This coating device is equipped with a rotary table 4 holding a base plate 3 by suction to face a flat coating surface upward and rotating and an elevating device elevating and lowering relatively to the coating head 5, the coating head 5 is divided into a 1st coating head for coating a circular coating surface to have an opening part as the radius and a 2nd coating head for coating a 1st ring-shaped coating surface (b) to have a circular coating surface (a) as the inscribed circle and the same coating surface area as that of the circular coating surface (a) and the coating is performed to uniformize the thickness of the primary coating film by the cooperation of the rotation of the base plate by the rotary table 4 with the quantitative discharge of the coating liquid by the 1st coating head and the 2nd coating head.



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**CLAIMS**

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[Claim(s)]

[Claim 1] The primary spreading film is formed by carrying out the quantum regurgitation of the coating liquid to the substrate which has an even spreading side using the spreading head which has opening of the shape of a straight line of predetermined width of face. A rotation maintenance means to be the rotating type coater which diffuses said primary spreading film in homogeneity according to the centrifugal force accompanying high-speed rotation, and forms the secondary spreading film, to turn said spreading side up, to hold a substrate by adsorption, and to rotate. A rise-and-fall means to go up and down relatively said spreading head and said rotation maintenance means. In the 1st spreading head which applies the circular spreading side which made said opening the radius for said spreading head the core [ the center of rotation of said rotation maintenance means ], and the outside of said circular spreading side. While dividing into each 2nd at least one or more spreading heads applied to at least one or more adjoining annular spreading sides made the same as the center of rotation of said circular spreading side. When said adjoining circular spreading side and said each annular spreading side touch on inner circumference and a periphery and it rotates for a unit co-operation of the quantum regurgitation per unit area of each locus by which said each spreading head is drawn on said circular spreading side and said each annular spreading side — said primary spreading film — abbreviation — the rotating type coater characterized by applying so that it may become the same thickness.

[Claim 2] The rotating type coater according to claim 1 characterized by adjusting the width of face and the sense of opening of said spreading head of 1, and said each 2nd spreading head, and making equal spreading area of each locus drawn on said circular spreading side and said each annular spreading side.

[Claim 3] The rotating type coater according to claim 2 which makes equal said the 1st and said width-of-face dimension of opening of each 2nd spreading head as said each 2nd spreading head meets the tangential direction of the inner circumference of said annular spreading side, and is characterized by making equal spreading area of each locus drawn on said circular spreading side and said each annular spreading side.

[Claim 4] The rotating type coater according to claim 3 characterized by considering as the set spreading head which prepared the coating liquid supply way which is open for free passage to each so that an abbreviation rectangular cross might be carried out to said opening while preparing said 1st spreading head and said each 2nd spreading head in one.

[Claim 5] The rotating type coater according to claim 4 characterized by setting up more greatly than said radius the width-of-face dimension of opening of each spreading head in said set spreading head.

[Claim 6] The rotating type coater according to claim 4 characterized by setting the width-of-face dimension of opening of each spreading head in said set spreading head as the abbreviation two times of said radius.

[Claim 7] The rotating type coater according to claim 4 characterized by arranging in the axial symmetry location of said 1st spreading head, respectively while setting the width-of-face dimension of opening of said 1st spreading head in said set spreading head as the abbreviation two times of said radius and setting the width-of-face dimension of opening of each of said 2nd spreading head as said radius.

[Claim 8] Carry out the quantum regurgitation of the coating liquid to the substrate which has an even

spreading side using the spreading head which has opening of the shape of a straight line of predetermined width of face, and the primary spreading film is formed. A rotation maintenance means to turn said spreading side up, to adsorb a substrate, to hold [ is the rotating type coater which diffuses said primary spreading film in homogeneity with the centrifugal force accompanying high-speed rotation, and forms the secondary spreading film, ], and to rotate, A rise-and-fall means to go up and down relatively said spreading head and said rotation maintenance means, The inside of the distance which made the periphery of the circular spreading side which made the starting position the center of rotation of said rotation maintenance means for said spreading head, and made said opening the radius the terminal point location, [ in the distance which made the periphery circle of the annular spreading side which makes a starting position the location which meets the tangential direction of said circular spreading side in general, and serves as the same spreading area as said circular spreading side the terminal point location ] the spreading effective area per unit time amount — \*\* — it having a spreading head migration means to control and drive the passing speed of said spreading head, one by one, and with rotation of the substrate by said rotation maintenance means so that it may become fixed co-operation of the quantum regurgitation of the coating liquid accompanying migration by said passing speed of said spreading head — said primary spreading film — abbreviation — the rotating type coater characterized by applying so that it may become the same thickness.

[Claim 9] The rotating type coater according to claim 8 characterized by applying further the annular spreading side located in the periphery side of said circular spreading side.

[Claim 10] The rotating type coater according to claim 8 characterized by having established a detection means to detect the distance to said spreading side, and enabling a setup of the gap of the discharge part tip of the spreading head of said spreading head migration means, and said spreading side in a predetermined gap with said rise-and-fall means.

[Claim 11] Said opening is a rotating type coater given in claim 1 characterized by being the slit nozzle which is open for free passage to passage thru/or any 1 term of 9.

[Claim 12] Said opening is a rotating type coater given in claim 1 characterized by being the nozzle which prepared the pore of a large number which are open for free passage to passage in the shape of an abbreviation straight line thru/or any 1 term of 9.

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#### **DETAILED DESCRIPTION**

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the rotating type coater which can realize \*\*\* spreading for using little coating liquid by the flat surface plasma display [ a semi-conductor substrate, a liquid crystal glass substrate, a printed circuit board, a plasma display, etc. ] substrate top, and forming the paint film of homogeneity thickness, when starting a rotating type coater, especially forming discharge and a paint film in the front face of coated members, such as flat sheet members, such as a

glass substrate and a metal plate, for coating liquid.

[0002]

[Description of the Prior Art] The rotating type coater by the spin coat method is known as equipment which applies resist liquid etc. to a substrate in a semi-conductor production process or the production process of a liquid crystal display at homogeneity.

[0003] While according to this rotating type coater the spreading side of a substrate was turned up, and a rear-face side is attracted and held and carried out low-speed rotation, it was what more coating liquid at the core is dropped, and homogeneity is diffused according to an operation of a centrifugal force by carrying out high-speed rotation after that, and shakes off excessive coating liquid. For this reason, the dozens to about 100 times coating liquid of the amount of paint film formation required for the spreading measuring area of one substrate is consumed. In many cases, since it was very expensive, coating liquid was the problem that the liquid waste was big.

[0004] Then, in order to control the consumption of coating liquid, the method of application for which spreading used the \*\*\*\*\* spreading head by predetermined width of face is proposed. That is, the technique which is going to form the thin film for which it asks by forming the primary spreading film by carrying out the quantum regurgitation of the coating liquid to the substrate which has an even spreading side using the spreading head which has opening of the shape of a straight line of predetermined width of face so that it may be indicated by JP,4-332116,A and JP,7-28715,A, diffusing the primary spreading film in homogeneity according to the centrifugal force accompanying high-speed rotation, and forming the secondary spreading film is known.

[0005] Moreover, in the circular substrate, a spreading head is arranged to the center of rotation of a substrate, and the approach of spreading measuring area mostly applied to the whole region is learned for rotating a substrate.

[0006] However, although the primary paint film obtained using the spreading head extended to radial becomes thin as it is impasto in the center section and goes to a substrate periphery from the difference in peripheral velocity, the quality of the secondary paint film obtained by high-speed rotation is determined throughout measuring area before high-speed rotation by how [ that carried coating liquid ] it is how. That is, since primary spreading in which a skip phenomenon does not occur in the periphery section is performed, spreading of Yamagata where a center section becomes high is avoided, and \*\*\*\* and liquid waste are not still canceled.

[0007] Thus, in order to improve the point that a center section grows into Yamagata, there are JP,59-112872,A and real proposal registration No. 3004824. It is made for tubing internal resistance to fall by shortening the die length of pore according to JP,59-112878,A, so that it is made to become so large that many pore nozzles arranged in the shape of a straight line and it go pore size to a rotation periphery and goes to a periphery. Moreover, the technique of the utility model registration No. 3004824 extends from the center of rotation, applying [ of a spreading head ] it to a periphery.

[0008] However, if the fluid fed from the passage which was open for free passage is in the inclination to flow the passage of low resistance, will establish a minute amount delivery in a center section especially aiming at \*\*\*\*, and will make the delivery in the periphery section large or will give a resistance difference, it may not be able to carry out the regurgitation to a center section at all. It is difficult for the approach of preparing an appropriate resistance difference in aperture width, and controlling discharge quantity to have a limitation, and to obtain the uniform primary spreading thin film as expected.

[0009] Then, after forming the primary spreading film applied the shape of stripes, and in the shape of a grid using the spreading head so that JP,10-284381,A may see, the equipment which diffuses the primary spreading film in homogeneity according to the centrifugal force accompanying high-speed rotation, and forms the secondary spreading film is also proposed.

[0010]

[Problem(s) to be Solved by the Invention] He is trying to make it move according to No. 3004824 of utility model registration on the other hand, arranging the sense of opening of a spreading head to radial

[ of a rotation substrate ], and controlling the speed in the direction of a periphery rotating a substrate. However, by this approach, the more it lengthens the die length of opening of a spreading head, the more it is necessary to devise the discharge quantity of a rotation center section and the periphery section. Moreover, if it shortens, since time amount most by the completion of spreading will be required, since the impasto by desiccation advance is not avoided, it has the problem that it must still improve, from the point of liquid effectiveness. Furthermore, since the primary spreading film proposed by JP,10-284381,A is not applied so that the high-speed hand of cut when forming the secondary spreading film may be met, it becomes difficult [ equalization ]. It is difficult to raise liquid effectiveness with the rotating type coater by the spin coat method as mentioned above, and to attain homogeneity thin film-ization of the secondary spreading film of a high precision.

[0011] Therefore, after this invention is made in view of the trouble mentioned above and forms the primary spreading film using a spreading head, it is set to the rotating type coater which forms the secondary spreading film according to the centrifugal force accompanying high-speed rotation. When applying the primary spreading film which has big effect on the secondary spreading film, the center section of substrate rotation becomes Yamagata, or it aims at offer of the rotating type coater which will not be in an uneven condition and can be applied with moreover more little coating liquid.

[0012]

[Means for Solving the Problem] In order to solve an above-mentioned technical problem and to attain the purpose, according to this invention, to the substrate which has an even spreading side The primary spreading film is formed by carrying out the quantum regurgitation of the coating liquid using the spreading head which has opening of the shape of a straight line of predetermined width of face. A rotation maintenance means to be the rotating type coater which diffuses said primary spreading film in homogeneity according to the centrifugal force accompanying high-speed rotation, and forms the secondary spreading film, to turn said spreading side up, to hold a substrate by adsorption, and to rotate, A rise-and-fall means to go up and down relatively said spreading head and said rotation maintenance means, In the 1st spreading head which applies the circular spreading side which made said opening the radius for said spreading head the core [ the center of rotation of said rotation maintenance means ], and the outside of said circular spreading side While dividing into each 2nd at least one or more spreading heads applied to at least one or more adjoining annular spreading sides made the same as the center of rotation of said circular spreading side When said adjoining circular spreading side and said each annular spreading side touch on inner circumference and a periphery and it rotates for a unit co-operation of the quantum regurgitation per unit area of each locus by which said each spreading head is drawn on said circular spreading side and said each annular spreading side — said primary spreading film — abbreviation — it is characterized by applying so that it may become the same thickness.

[0013] Moreover, carry out the quantum regurgitation of the coating liquid to the substrate which has an even spreading side using the spreading head which has opening of the shape of a straight line of predetermined width of face, and the primary spreading film is formed. A rotation maintenance means to turn said spreading side up, to adsorb a substrate, to hold [ is the rotating type coater which diffuses said primary spreading film in homogeneity with the centrifugal force accompanying high-speed rotation, and forms the secondary spreading film, ], and to rotate, A rise-and-fall means to go up and down relatively said spreading head and said rotation maintenance means, The inside of the distance which made the periphery of the circular spreading side which made the starting position the center of rotation of said rotation maintenance means for said spreading head, and made said opening the radius the terminal point location, [ in the distance which made the periphery circle of the annular spreading side which makes a starting position the location which meets the tangential direction of said circular spreading side in general, and serves as the same spreading area as said circular spreading side the terminal point location ] the spreading effective area per unit time amount — \*\* — it having a spreading head migration means to control and drive the passing speed of said spreading head, one by one; and with rotation of the substrate by said rotation maintenance means so that it may become fixed co-

operation of the quantum regurgitation of the coating liquid accompanying migration by said passing speed of said spreading head — said primary spreading film — abbreviation — it is characterized by applying so that it may become the same thickness.

[0014]

[Embodiment of the Invention] Below, each suitable operation gestalt of this invention is described with reference to an accompanying drawing.

[0015] Drawing 1 is the appearance perspective view having shown the whole rotating type coater 1 configuration. Moreover, drawing 2 is the top view (a) having shown the rotary table 4 of illustration, and the physical relationship of the spreading head 5 in drawing 1, this front view (b), and (c).

[0016] In drawing 1, a desired paint film is formed by exchanging the flat surface plasma display [ a semi-conductor substrate a liquid crystal glass substrate, a printed circuit board, a plasma display, etc. ] substrate 3 between equipment other than the rotating type coater 1 in the condition of having been laid on the fork 16 of a pair like illustration. On the base 2 of this equipment 1, the body side of the motor 11 mentioned later is being fixed. The rotary table 4 by which a rotation drive is carried out is formed in the direction of an arrow head at the low speed and the high speed at upper opening of equipment 1 by receiving power from the output shaft of this motor 11, or a non-illustrated motor. This rotary table 4 has the even circular adsorption side like illustration, and countless adsorption hole 4a for carrying out suction maintenance of the substrate 3 by supplying vacuum pressure through a bulb 14 from a vacuum generator 15 on that adsorption side is prepared.

[0017] About migration of the vertical direction, it carries out in rise-and-fall actuation of the rise-and-fall motor 12 fixed to a base 2.

[0018] It is constituted so that a substrate 3 can be laid and transferred on the fork 16 of non-illustrated robot equipment by the above configuration, since the below-mentioned spreading is performed as it goes up and down a rotary table 4 relatively to the spreading head 5 arranged up, and the spreading head 5 is evacuated.

[0019] Scattering prevention of the superfluous coating liquid which disperses with high-speed rotation of a rotary table 4 is carried out, and the recovery case 9 which carries out recovery processing is formed in the periphery side of a rotary table 4.

[0020] On the other hand, piping which introduces the coating liquid supplied through a bulb 7 from the coating liquid feeder 6, and piping connected to the condom bulb 8 which attracts coating liquid compulsorily from the spreading head 5 interior immediately after spreading are prepared in the five same spreading heads 5 like illustration, and the below-mentioned spreading is enabled. It connects with the control unit 10, and the above each bulb and motor are constituted so that it can interlock and operate based on the directions from a control unit 10.

[0021] Next, in drawing 2 (a), arrangement and the spreading principle of each spreading head 5 are explained.

[0022] 1st spreading head 5A arranges an end to the center of rotation O, and arranges opening of the width-of-face dimension h in the direction of y. Consequently, if a rotary table 4 rotates by 360 degrees in the direction of an arrow head, the circular spreading side a of the area of  $\pi h^2$  which made opening the radius will be applied.

[0023] Next, it is arranged so that opening may meet the tangential direction of the circular spreading side a in general, and the circular spreading side a is made into an inscribed circle, and it arranges like illustration of 2nd spreading head 5B which applies the 1st annular spreading side b used as the same spreading area as the circular spreading side a.

[0024] Since it can ask for the spreading area applied by this 2nd spreading head 5B from the formula in drawing by Pythagorean theorem of a right triangle, it serves as the 1st annular spreading side b of the area of  $\pi h^2$  which is the area of the circular spreading side a, and  $\pi h^2$  which is the same area.

[0025] Furthermore, 3rd spreading head 5C which applies the 2nd annular spreading side c which made the inscribed circle the periphery circle of the 1st annular spreading side b by being arranged so that

opening may meet the tangential direction of the periphery circle of this 1st annular spreading side b in general is arranged further.

[0026] By opening being hereafter, arranged so that opening may meet the tangential direction of the periphery circle of the 2nd annular spreading side c in general similarly By 4th spreading head 5D which applies the 3rd annular spreading side d which makes an inscribed circle the periphery circle of the 2nd annular spreading side c, and being arranged so that opening may meet the tangential direction of the periphery circle of the 3rd annular spreading side d in general 5th spreading head 5E which applies 4th annular spreading \*\*\*\* e which makes an inscribed circle the periphery circle of the 3rd annular spreading side d is arranged.

[0027] It arranges so that the parallel displacement of the spreading head 5 same as mentioned above may be carried out in the direction of a x axis in drawing. When the one revolution of each above spreading heads 5A-5E is carried out applying a spreading fluid in the same length as a slot nozzle in which the quantum regurgitation of the same aperture width is possible, equivalent spreading will be carried out altogether. Each average thickness of the coating liquid applied to the spreading side of each a [ centering on center-of-rotation O ], and b, c, d and e with each spreading head as shown in drawing 2 (b) comes to spread abbreviation etc. on the circle a circular rings b, c, d, and e drawn on Disk P.

[0028] Consequently, the primary spreading film of average thickness T equalized, so that it did not become as compared with drawing 2 (c) which is thickness distribution of the broken-line illustration at the time of applying with the conventional spreading head 105 illustrated with the broken line for the comparison can be formed, high-speed rotation is carried out after that, a homogeneity paint film can be formed, and coating liquid [ surplus moreover ] also decreases extremely.

[0029] That is, it will be notably different when it is made to become equal to the inclination (inclination of the proposal annular circle e) of the paint film which forms in the periphery section thickness distribution of the broken-line illustration when making a center-of-rotation location apply the slot which has the radius or diameter of one spreading area to the substrate which arranged and rotates in the edge or center section, and forming it in it.

[0030] Thus, by applying by the equivalent regurgitation spreading head [ like ] which can be divided into area [ measuring area / spreading ], thin film spreading of equal thickness is attained in general. Moreover, although the drawing showed cartographical sketching which intersects perpendicularly so that a tangential direction may be met and by which opening of a spreading head is arranged, you may make it each incline to the y-axis.

[0031] Drawing 3 is the sectional view of the spreading head 5, (a) is the cross-sectional view fractured and shown in the longitudinal direction of opening, and (b) is drawing of longitudinal section which intersected perpendicularly with opening, and was fractured and illustrated.

[0032] In drawing 3, as each spreading heads 5A-5E intervene and pile up the spacing member 17 which has different thickness of three sheets like illustration with a non-illustrated bolt nut, they are completed. After completion, while it is mutually open for free passage, the passage 18 where the entrance was connected to an above-mentioned feeder 6 and the above-mentioned condom bulb 8 is formed. By this passage and 18, coating liquid is similarly supplied adequately in the space section 19 of each spreading head. The space section 19 is open for free passage to opening of a slot 20, and can be made to carry out the tales-doses regurgitation in the direction of an arrow head from the tip.

[0033] As mentioned above, each spreading head can be opened for free passage to opening of the slit 20 which forms the slot of the width-of-face dimension W (namely, the width-of-face dimension h of opening), can have die length almost equivalent to opening length in the upper part of opening, and can stabilize for it and send out a pressure flow object to the slot section. The supply timing of coating liquid is controlled by turning on and off of a closing motion bulb as a set spreading head which has arranged plurality and a spreading head for such a spreading head at suitable spacing. Moreover, the closing motion bulb is prepared also in the exhaust port. If a slot gap makes slot height high enough narrowly enough, opens the bulb of discharge RO (atmospheric pressure) and supplies liquid from an inlet, by slot

wall resistance, liquid will be filled in the space section 19 of each spreading head through penetration opening, and will result in an exhaust port.

[0034] Then, if the closing motion bulb of an exhaust port is closed, liquid will come to be breathed out from a slot point. If this is repeated several times, in a spreading head, the condition of having become full with the liquid with which air bubbles do not exist can be made. Then, the closing motion bulb of supply RO is closed, and if liquid is attracted by the condom bulb prepared in the point of the closing motion bulb of discharge RO, since the liquid of a regurgitation opening point can be drawn in a slot, the closing motion bulb of an exhaust port is closed immediately after. If it will be in this condition, it will be in the standby condition which can start spreading. In addition, as long as the fluid supply to a feed hopper is supplied by the fixed pressure, it may use what kind of means.

[0035] In order to make the gap of the point of opening of the spreading head of such a configuration, and the spreading side of the rotating substrate into a predetermined value, it applies, making it go up and down relatively, but if the rise-and-fall timing is immediately after opening the supply bulb of a spreading head, coating liquid's oozing at the tip of spreading head and it forming small \*\*\*\* continuously, it is more good.

[0036] Thus, if it applies and defined angle of rotation is reached until a substrate 3 does beyond 360-degree rotation of, the closing motion bulb 7 prepared before the liquid inlet will be closed, and liquid is attracted from a liquid exhaust port, and rise-and-fall migration of a spreading head or the substrate 3 applied is carried out with a rise-and-fall means. Thus, the primary spreading film with which the paint film of the small ripple wave to which the formed spreading side balances the number of installation of a spreading head will be formed, the average thickness  $T$  between the spreading sides of the shape of each ripple became the same thickness, and the whole region changed into the condition of spreading measuring area of having been soaked in coating liquid, mostly can be obtained. The secondary spreading film of the homogeneous membrane thickness for which it asks by controlling the rotational frequency of a rotary table 4 next so that predetermined time carries out high-speed rotation of the substrate can be obtained.

[0037] Since the part which secures the linearity at the tip of slit opening here compared with manufacture of the spreading head which has opening for a diameter of a rotary table like before by setting up the width-of-face dimension of opening of each spreading head in a set spreading head like a radius as mentioned above becomes short, a production process becomes very easy.

[0038] Drawing 4 (a) - (e) is the plot plan of a spreading head. In this Fig., what was mentioned above was what arranged opening of a slot one by one so that it might touch \*\* outside to the circle which positions the end of opening located in a center section to the center of rotation, and other ends draw, and the width-of-face dimension  $h$  of opening of the slot of a center section was the radius of the circle to draw, and was what can form a primary paint film in the state of a ripple as mentioned above on the theory. drawing 4 (b) — the width of face of opening of each spreading head 5 —  $h$  — the lap part of a ripple is made more to homogeneity by preparing big aperture width excessive for 1 minute, and doing in this way. Moreover, he is trying for drawing 4 (c) to serve as a diameter of circle which will be drawn if the width-of-face dimension of opening makes it  $2h$  and arranges the core of center-section slot open RO to the center of rotation. Moreover, drawing 4 (d) sets the width-of-face dimension of slot opening of the center section of the spreading head to  $2h$  which is twice other spreading heads, and arranges 2 grouping of spreading heads of opening of the width-of-face dimension  $h$  in a point symmetry location focusing on a center-of-rotation point. And drawing 4 (e) sets the width-of-face dimension of slot opening of the center section of the spreading head to  $2h$  which is twice other spreading heads, and arranges 2 grouping of spreading heads of opening of the width-of-face dimension  $h$  in the axial symmetry location of opening of the spreading head of this core.

[0039] In drawing 4 (a) - (c), it should just be 180 degrees or more which has angle of rotation required 360 degrees or more at the time of spreading in arranging a spreading head like illustration to drawing 4 (d) and (e).



[0040] In addition, it cannot be overemphasized that it does not change to a principle at all even if it does not arrange slot opening located in the center of the spreading head made the above configurations not necessarily in parallel with other slot openings, but prepares an include angle or makes it intersect perpendicularly.

[0041] Next, drawing 5 (a) is drawing explaining the condition of the spreading circle which each spreading head when applying to the substrate 3 of a rectangle like illustration with the spreading head 5 shown by drawing 5 draws, and the rotating substrate. Drawing 5 (b) removes spreading head 5D and spreading head 5E, and carries out spreading head 5C extension, and drawing 5 (c) is drawing which extended spreading head 5C twice.

[0042] When the liquid discharge quantity consumed in 1 cycle spreading actuation by drawing 5 (a) and drawing 5 (c) was measured and coverage of drawing 5 (a) is set to "5", it is set to "4" in drawing 5 (c). Moreover, since spreading head 5C of drawing 5 (c) has protruded the part out of the annular spreading side e, if it stores in this annular spreading circle e, as shown in drawing 5 (b), it will serve as coverage below "4." The average spreading thickness in the circular spreading side a and the annular spreading circle b although spreading head 5C of drawing 5 (b) will be applied to the annular circles c, d, and e becomes almost equal to the annular spreading sides a and b, although a part of average thickness of the annular spreading side c is also liable to being thicker a little equally.

[0043] Although it will apply to a substrate by delta of spreading head 5C, and opening for eta in respect of [ d and c ] annular spreading, the spreading effective area on a substrate 3 is [ several / of annular spreading side d / 1/ ], and drops to 1/dozens of the annular spreading side e. That is, as shown in the example of drawing 5 (b), high spreading of liquid effectiveness can be realized by making the die length of spreading head 5C into suitable die length.

[0044] Moreover, although the end of spreading head 5C was extended in the example of drawing 5 (b), according to the die length of the size of a substrate 3, or opening, the both ends of spreading head 5C can be extended suitably, or arrangement of spreading head 5C can be brought near in the direction of spreading head 5B, and you can apply the spreading film of the periphery section thickly, and can make it spread in high-speed rotation. Moreover, it cannot be overemphasized that a width-of-face dimension, a liquid supply pressure, etc. of the number of the spreading heads 5 or opening are suitably selected from the viscosity of the configuration of a substrate, size, the thickness of the request film, and the liquid for spreading etc.

[0045] If the opening die length of the spreading head 5 is bound tight with a bolt 22 on both sides of SIMM 21 and forms the spreading head 5 between two wall surfaces like illustration in the cross-sectional view and drawing of longitudinal section (b) of drawing 6 (a), it is possible opening length and an opening location, and to change aperture width W easily further by SIMM exchange. It cannot be overemphasized that the SIMM of all the spreading heads that constitute a spreading head, of course is equal thickness.

[0046] Next, drawing 7 is the top view having shown the principle-of-operation Fig. of the rotating type coater of the 2nd operation gestalt. Moreover, drawing 8 is the front view having shown the motion of a spreading head, and is drawing having shown the position in readiness (a), the spreading starting position (b), and the substrate ejection location.

[0047] If the sign same about a component part [ finishing / explanation / already ] is first attached in drawing 8 and explanation is omitted, as for the spreading head 5, only one is carried in the non-illustrated head migration elevator style in drawing 8 . The distance robot 26 is being fixed to this spreading head 5, it moves, measuring the distance between a substrate 3 and opening, and it is constituted so that spreading accompanying migration of a up to [ a substrate 3 ] can be performed to drawing 8 like illustration. Moreover, as the fork 16 of the pair of non-illustrated robot equipment is the side face of the peripheral face of a rotary table 4 in the location of drawing 8 (c) and the rotary table 4 currently fixed to the upper limit of the ball castellated shaft 30 (broken-line illustration) used as the output shaft of the above-mentioned motor 11 infiltrates under the substrate 3, it is constituted so that

a substrate 3 can be laid, while being moved up with the energization to the rise-and-fall motor 12 like illustration.

[0048] In drawing 7, although the end of spreading head 5A is arranged equally in the center of rotation and the other end applied the width-of-face dimension of opening of each spreading head 5 mentioned above to the peripheral face of the circular spreading side a, the ratio of spacing of each spreading heads 5A-5E at this time is as follows from Pythagorean theorem of a right triangle, when spreading head 5A and h which is the die length AB between 5B are set to "1."

[0049]  $AB:BC:CD:DE:DF : \dots = 1:\sqrt{2}-1:\sqrt{3}-\sqrt{2}:\sqrt{4}-\sqrt{3}:\sqrt{5}-\sqrt{4} : \dots$  It follows  $\sqrt{n}-\sqrt{n-1}$ . If passing speed control is performed so that the time amount to which the spreading head 5 moves between each distance AB, BC, CD, and DE between these spreading heads and DF may become equal the bottom of the condition that the discharge quantity and the substrate rotational frequency of a spreading head per unit time amount are certain — setting — the spreading sides a, b, c, and d and — spreading thickness all over the districts will become fixed mostly. Then, it is made to perform migration control of the same spreading head 5 so that the part illustrated with a broken line in drawing 7 may be made into a radix point and a terminal point. However, near a spreading start point and the completing point, it will vary somewhat.

[0050] There are the approach of starting spreading from those with two kind and a rotation center section and the approach of starting from the periphery section in the above spreading actuation. In starting from a rotation center section, from the upper part position in readiness P1 of the substrate 3 which carries out low-speed rotation like the illustration to drawing 7 (b), move aslant at high speed, coating liquid is made to land to the front face of a substrate 3 in this side location P2 of the center of rotation, dropping a spreading head starting the liquid regurgitation, and it applies by performing moderation control from a center-of-rotation location to a terminal point. The inside of a substrate or the outside of a substrate 3 is sufficient as a terminal point location.

[0051] Moreover, when starting from the periphery side of a substrate 3, it is the approach of beginning from E location shown in drawing 7 (a), setting a revolving substrate front face and a revolving spreading head tip as a predetermined gap, starting the coating liquid regurgitation, and moving toward the center of rotation. The spreading head is a idle state at the time of this initiation, and it accelerates gradually, and it drives so that a spreading head may be raised in the location which exceeded the center of rotation or a core.

[0052] If migration spreading is started controlling the speed in acceleration and deceleration to such a rotating substrate, it will become possible to perform almost uniform primary spreading except for the initiation section and the terminal point section also in which the above-mentioned approach. The uniform secondary paint film for which it asks by carrying out high-speed rotation next can be obtained.

[0053] By applying as mentioned above, it becomes unnecessary [ surplus coating liquid ] and \*\*\*\* spreading with high liquid effectiveness can be realized. The die length of the spreading head 5 and the location of a spreading head edge become usable [ the short length spreading head which can be manufactured by low cost ] from the spreading head of the conventional rotating type coater that what is necessary is just to select suitably as shown in drawing 5. Moreover, even if this approach is not only effective as a \*\*\*\* applying method of a circular substrate, but it is a rectangle substrate, it cannot be overemphasized that the \*\*\*\* effectiveness becomes high by controlling the rate near the rotation periphery section suitably.

[0054] Here, the gap on the front face of spreading of tip opening of a spreading head and a substrate serves as an element more important as thin film spreading is pursued. the gap when performing wet film spreading of several micrometer thickness — dozens — when about micrometer\*\*20micrometer is good and becomes less than [ it ], there is a possibility that possibility of being soiled except the point of a spreading head may become high, and the dirt liquid may soil the following object with \*\*\*\*\* formed in a spreading head tip and a substrate front face in the activity produced continuously.

[0055] Moreover, if it becomes more than it, possibility that it will become difficult to continue

throughout spreading head opening length and to form the fluid of the shape of a curtain until it reaches [ from a spreading tip ] a substrate front face with surface tension, and a part will go out will become high. Furthermore, about 10–20 micrometers of board thickness of a substrate 3 change with lots. It becomes important, when raising the quality and liquid effectiveness of the primary spreading film to act as a monitor by the distance sensor 26 as mentioned above, to detect the height on the front face of a substrate, and to set up a suitable gap for every one substrate from this, when performing thin film spreading.

[0056] It may not stop at carrying out the regurgitation of the spreading head used as mentioned above from slit-like opening as mentioned above, but an opening configuration may be the nozzle which formed much pores 23 in the shape of an abbreviation straight line like the illustration to (c) from drawing 9 (a). That is, when the regurgitation of the fluid in the condition of having contained the liquid tip in the spreading head nozzle when the condition of the fluid at the time of carrying out the regurgitation of the fluid from a spreading head was explained is carried out, a discharge flow object will form \*\*\*\* of the shape of a very small semi-sphere at the tip of spreading head first. After forming \*\*\*\* of the shape of this semi-sphere over the opening whole region, if spacing of a head tip and a substrate is shortened to a predetermined value, \*\*\*\* will be crushed, and the film of liquid DAMARI which followed the spreading head opening overall length will be formed. When it is made to run a spreading head or a substrate relatively from this condition, crushed \*\*\*\* (surplus liquid of impasto) will be extended in transit actuation. Thus, when \*\*\*\* formed in a point is able to arrange mostly Kodama of a 0.several or less mm diameter in at equal intervals, it is checked that spreading quality is high.

[0057] If the same is said of the pore nozzle of the illustration to drawing 9, much semi-sphere-like \*\*\*\* are formed at many tips of a pinhole at the time of the fluid regurgitation and it is made to become a substrate front face and a predetermined gap, continuous \*\*\*\* can be formed over an opening overall length. The constant pitch array of the pore 23 of a pinhole is carried out, and pore is prepared in drawing 9 (a) to a tip like illustration, or you may make it prepare the spreading head which the shape of \*\* followed further in an edge like the illustration to drawing 9 (b) in the structure of such a spreading head nozzle.

[0058] When it is made such a pore configuration, since a discharge part can be created by block processing of one, manufacture cost can be reduced and there is effectiveness which can make handling easy.

[0059] Not one but the thing divided into two may not necessarily be used for a block. Moreover, not only a round hole but an angle hole is sufficient as a pore configuration, and if it is the pore of the same configuration, it will not ask a configuration.

[0060] As mentioned above, while it is uniform in general at little coating liquid to the substrate which carries out low-speed rotation by using a motor and obtaining quickly the primary paint film from which a substrate center section does not become Yamagata, the low noise and the \*\*\*\* paint film of low vibration can be obtained, and further upgrading can be realized.

[0061]

[Effect of the Invention] In the rotating type coater which forms the secondary spreading film according to the centrifugal force accompanying high-speed rotation after forming the primary spreading film using a spreading head according to this invention, as explained above When applying the primary spreading film which has big effect on the secondary spreading film, the center section of substrate rotation can become Yamagata, or the rotating type coater which will not be in an uneven condition and can be applied with moreover more little coating liquid can be offered.

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[Translation done.]

**\* NOTICES \***

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

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**DESCRIPTION OF DRAWINGS**

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**[Brief Description of the Drawings]**

**[Drawing 1]** It is the appearance perspective view of the rotating type coater of the 1st operation gestalt.

**[Drawing 2]** (a) They are the top view showing the spreading principle of operation of drawing 1, the front view of (b) drawing 2 (a), and the front view having shown the comparison with the paint film of (c) former.

**[Drawing 3]** (a) They are the cross-sectional view of a spreading head, and drawing of longitudinal section of (b) spreading head.

**[Drawing 4]** (a) It is the top view showing the spreading principle of operation of -(e) another operation gestalt.

**[Drawing 5]** (a) It is the top view showing the spreading principle of operation of -(c) another operation gestalt.

**[Drawing 6]** (a) They are the cross-sectional view of a spreading head, and drawing of longitudinal section of (b) spreading head.

**[Drawing 7]** (a) It is the top view and the operating state Fig. of (b) spreading head showing the spreading principle of operation of the rotating type coater of the 2nd operation gestalt.

**[Drawing 8]** (a) It is the front view of explanation of - (c) coater of operation.

**[Drawing 9]** (a) They are the cross-sectional view of a spreading head, and drawing of longitudinal section of (b) spreading head.

**[Description of Notations]**

**1 Rotating Type Coater**

**2 Base**

**3 Substrate**

**4 Rotary Table**

**5 Spreading Head**

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**[Translation done.]**

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(71)出願人 391032358

平田機工株式会社

東京都品川区戸越3丁目9番20号

(72)発明者 春川 澄夫

東京都品川区戸越3丁目9番20号 平田機  
工株式会社内

(74)代理人 100076428

弁理士 大塚 康徳 (外2名)

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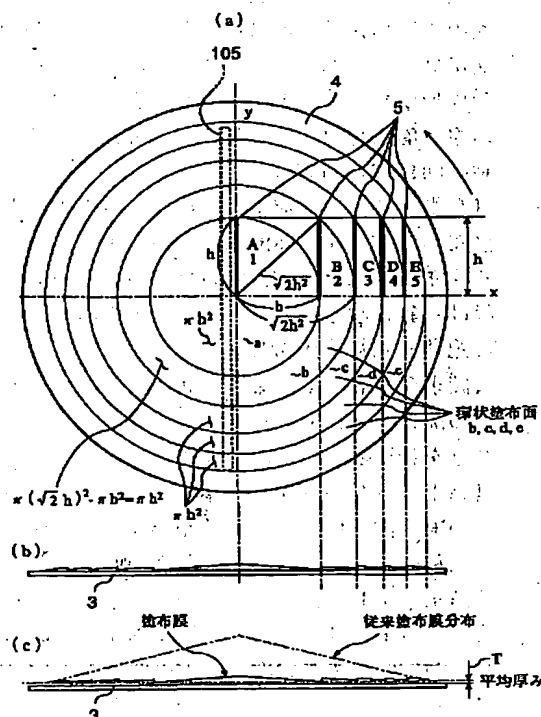
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(54)【発明の名称】 回転式塗布装置

(57)【要約】

【課題】 塗布ヘッドを用いて一次塗布膜を形成した後、高速回転にともなう遠心力により二次塗布膜を形成するときに、二次塗布膜に大きな影響を与える一次塗布膜が基板回転の中央部が山形になったり、不均一な状態となることがなく、しかもより少ない塗布液で塗布できるようにする。

【解決手段】 平らな塗布面を上にして基板3を吸着により保持して、回転する回転テーブル4と、塗布ヘッド5と相対的に昇降する昇降装置とを備えており、塗布ヘッド5を開口部を半径とした円形塗布面を塗布する第1の塗布ヘッド5Aと、円形塗布面aを内接円とし、円形塗布面aと同じ塗布面積となる第1の環状塗布面bを塗布する第2の塗布ヘッド5Bとに少なくとも分割するとともに、回転テーブル4による基板の回転と、第1の塗布ヘッド及び前記第2の塗布ヘッドによる塗布液の定量吐出の協働により、一次塗布膜が略同じ厚さとなるように塗布する。



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(2)

## 【特許請求の範囲】

【請求項1】 平らな塗布面を有する基板に、所定幅の直線状の開口部を有する塗布ヘッドを用いて塗布液を定量吐出することで一次塗布膜を形成し、高速回転にともなう遠心力により前記一次塗布膜を均一に拡散して二次塗布膜を形成する回転式塗布装置であって、前記塗布面を上にして基板を吸着により保持し、回転する回転保持手段と、前記塗布ヘッドと前記回転保持手段とを相対的に昇降する昇降手段と、前記塗布ヘッドを、前記回転保持手段の回転中心を中心とし、前記開口部を半径とした円形塗布面を塗布する第1の塗布ヘッドと、前記円形塗布面の外側において、前記円形塗布面の回転中心と同じとする少なくとも1つ以上の隣接する環状塗布面に対して塗布する少なくとも1つ以上の第2の各塗布ヘッドとに分割するとともに、隣接する前記円形塗布面及び前記各環状塗布面は内周及び外周で接し、単位分の回転したときに、前記各塗布ヘッドが前記円形塗布面及び前記各環状塗布面上に描かれる各軌跡の単位面積当たりの定量吐出の協働により、前記一次塗布膜が略同じ厚さとなるように塗布することを特徴とする回転式塗布装置。

【請求項2】 前記1の塗布ヘッドと前記第2の各塗布ヘッドの開口部の幅と向きを調整して、前記円形塗布面及び前記各環状塗布面上に描かれる各軌跡の塗布面積を等しくすることを特徴とする請求項1に記載の回転式塗布装置。

【請求項3】 前記第2の各塗布ヘッドが前記環状塗布面の内周の接線方向に沿うようにして、前記第1及び前記第2の各塗布ヘッドの開口部の幅寸法を等しくし、前記円形塗布面及び前記各環状塗布面上に描かれる各軌跡の塗布面積を等しくすることを特徴とする請求項2に記載の回転式塗布装置。

【請求項4】 前記第1の塗布ヘッドと、前記第2の各塗布ヘッドとを一体的に設けるとともに、夫々に連通する塗布液供給路を前記開口部に対して略直交するように設けた集合塗布ヘッドとすることを特徴とする請求項3に記載の回転式塗布装置。

【請求項5】 前記集合塗布ヘッドにおける各塗布ヘッドの開口部の幅寸法を、前記半径よりも大きく設定することを特徴とする請求項4に記載の回転式塗布装置。

【請求項6】 前記集合塗布ヘッドにおける各塗布ヘッドの開口部の幅寸法を、前記半径の略二倍に設定することを特徴とする請求項4に記載の回転式塗布装置。

【請求項7】 前記集合塗布ヘッドにおける前記第1の塗布ヘッドの開口部の幅寸法を前記半径の略二倍に設定し、前記第2の各塗布ヘッドの開口部の幅寸法を前記半径に設定するとともに、前記第1の塗布ヘッドの線対称

位置にそれぞれ配設したことを特徴とする請求項4に記載の回転式塗布装置。

【請求項8】 平らな塗布面を有する基板に、所定幅の直線状の開口部を有する塗布ヘッドを用いて塗布液を定量吐出して一次塗布膜を形成し、高速回転にともなう遠心力で前記一次塗布膜を均一に拡散して二次塗布膜を形成する回転式塗布装置であって、前記塗布面を上にして基板を吸着して保持し、回転する回転保持手段と、

10 前記塗布ヘッドと前記回転保持手段とを相対的に昇降する昇降手段と、前記塗布ヘッドを、

前記回転保持手段の回転中心を開始位置とし、前記開口部を半径とした円形塗布面の外周を終点位置とした距離内と、

前記円形塗布面の接線方向に概ね沿う位置を開始位置とし前記円形塗布面と同じ塗布面積となる環状塗布面の外周円を終点位置とした距離内において、単位時間当たりの塗布有効面積が概一定になるように、順次、前記塗布ヘッドの移動速度を制御して駆動する塗布ヘッド移動手段とを備え、

前記回転保持手段による基板の回転と、前記塗布ヘッドの前記移動速度による移動に伴う塗布液の定量吐出の協働とにより、前記一次塗布膜が略同じ厚さとなるように塗布することを特徴とする回転式塗布装置。

【請求項9】 前記円形塗布面の外周側に位置する環状塗布面をさらに塗布することを特徴とする請求項8に記載の回転式塗布装置。

【請求項10】 前記塗布面までの距離を検出する検出手段を設け、前記塗布ヘッド移動手段の塗布ヘッドの吐出部先端と前記塗布面との間隙を前記昇降手段で所定の間隙に設定可能にしたことを特徴とする請求項8に記載の回転式塗布装置。

【請求項11】 前記開口部は、流路に連通するスリットノズルであることを特徴とする請求項1乃至9のいずれか1項に記載の回転式塗布装置。

【請求項12】 前記開口部は、流路に連通する多数の細孔を略直線状に設けたノズルであることを特徴とする請求項1乃至9のいずれか1項に記載の回転式塗布装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、回転式塗布装置に係り、特に硝子基板や金属板などの平坦な枚葉部材などの被塗布部材の表面に塗布液を吐出し、塗膜を形成するときに、半導体基板や液晶硝子基板やプリント基板およびプラズマディスプレイ等の平面な基板上により少ない塗布液を用いて均一厚さの塗膜を形成するための省液塗布を実現できる回転式塗布装置に関する。

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【0002】

【従来の技術】半導体製造工程や液晶表示装置の製造工程において基板にレジスト液等を均一に塗布する装置としてスピコート法による回転式塗布装置が知られている。

【0003】この回転式塗布装置によれば、基板の塗布面を上にして裏面側を吸引して保持し、低速回転させながら、中心に多めの塗布液を落下させ、その後、高速回転させることで遠心力の作用により均一に拡散させ、かつ余分な塗布液を振り切るものであった。このために、1枚の基板の塗布有効面に必要な塗膜形成量の数十倍から百倍近くの塗布液を消費している。塗布液は、多くの場合極めて高価であるために、その液浪費が大きな問題であった。

【0004】そこで、塗布液の消費量を抑制するために所定幅で塗布がてきる塗布ヘッドを用いた塗布方法が提案されている。すなわち、特開平4-332116号公報や特開平7-28715号公報に開示されるように、平らな塗布面を有する基板に、所定幅の直線状の開口部を有する塗布ヘッドを用いて塗布液を定量吐出することで一次塗布膜を形成し、高速回転にともなう遠心力により一次塗布膜を均一に拡散して二次塗布膜を形成することで所望する薄膜を形成しようとする技術が知られている。

【0005】また、円形基板においては、塗布ヘッドを基板の回転中心に配置し、基板を回転させることで塗布有効面のほぼ全域に塗布する方法が知られている。

【0006】しかしながら、半径方向に伸びた塗布ヘッドを用いて得られる一次塗膜は周速度の違いから、中央部で厚塗りであり基板外周にいくにつれ薄くなるが、高速回転で得られる二次塗膜の品質は、高速回転前に有効面全域に均一に塗布液を載せたどうかで決定される。すなわち、外周部でカスレ現象が起きないような一次塗布を行なうことから、中央部が高くなる山形の塗布は避けられず、液浪費は依然として解消されない。

【0007】このように中央部が山形に成る点を改善するために、特開昭59-112872号公報や実案登録3004824号がある。特開昭59-112878号公報によれば、多数の細孔ノズルを直線状に配置し細孔径を回転外周に行くほど大きくなるようにしたり、また外周に行くほど細孔の長さを短くすることで管内抵抗が低下するようにしたものである。また、実用新案登録3004824号の技術は塗布ヘッドの開口幅を回転中心から外周にかけて広げるものである。

【0008】しかしながら、連通した流路から圧送する流体は低い抵抗の流路を流れる傾向にあり、特に省液を目指して微量吐出口を中央部に設け外周部における吐出口を広くしたり抵抗差をつけようものなら中央部には全く吐出できない場合がある。開口幅にそれなりの抵抗差を設け吐出量を制御する方法は限界があり、期待通りの

均一な一次塗布薄膜を得ることは難しい。

【0009】そこで、特開平10-284381号公報に見られるように、塗布ヘッドを用いて縞状または格子状に塗布した一次塗布膜を形成した後に、高速回転にともなう遠心力により一次塗布膜を均一に拡散して二次塗布膜を形成する装置も提案されている。

【0010】

【発明が解決しようとする課題】一方、実用新案登録の3004824号によれば、基板を回転させつつ塗布ヘッドの開口部の向きを回転基板の半径方向に配置し、外周方向へ速度制御を行ないながら移動させるようにしている。しかしながら、この方法では塗布ヘッドの開口部の長さを長くすればするほど回転中央部と外周部との吐出量を工夫する必要がある。また、短くすると塗布完了までかなりの時間を要することから、乾燥進行による厚塗りは避けられないので液効率の点からはまだ改善しなければならないといった問題がある。さらに、特開平10-284381号公報に提案された一次塗布膜は、二次塗布膜を形成するときの高速回転方向に沿うように塗布されないで、均一化は困難となる。以上のようにスピコート法による回転式塗布装置で液効率を向上させ、高い精度の二次塗布膜の均一薄膜化を図ることは難しい。

【0011】したがって、本発明は上述した問題点に鑑みてなされたものであり、塗布ヘッドを用いて一次塗布膜を形成した後に、高速回転にともなう遠心力により二次塗布膜を形成する回転式塗布装置において、二次塗布膜に大きな影響を与える一次塗布膜を塗布するときに、基板回転の中央部が山形になったり、不均一な状態となることがなく、しかもより少ない塗布液で塗布することができる回転式塗布装置の提供を目的としている。

【0012】

【課題を解決するための手段】上述の課題を解決し、目的を達成するために、本発明によれば、平らな塗布面を有する基板に、所定幅の直線状の開口部を有する塗布ヘッドを用いて塗布液を定量吐出することで一次塗布膜を形成し、高速回転にともなう遠心力により前記一次塗布膜を均一に拡散して二次塗布膜を形成する回転式塗布装置であって、前記塗布面を上にして基板を吸着により保持し、回転する回転保持手段と、前記塗布ヘッドと前記回転保持手段とを相対的に昇降する昇降手段と、前記塗布ヘッドを、前記回転保持手段の回転中心を中心とし、前記開口部を半径とした円形塗布面を塗布する第1の塗布ヘッドと、前記円形塗布面の外側において、前記円形塗布面の回転中心と同じとする少なくとも1つ以上の隣接する環状塗布面に対して塗布する少なくとも1つ以上の第2の各塗布ヘッドとに分割するとともに、隣接する前記円形塗布面及び前記各環状塗布面は内周及び外周で接し、単位分の回転したときに、前記各塗布ヘッドが前記円形塗布面及び前記各環状塗布面上に描かれる各軌跡

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の単位面積当たりの定量吐出の協働により、前記一次塗布膜が略同じ厚さとなるように塗布することを特徴としている。

【0013】また、平らな塗布面を有する基板に、所定幅の直線状の開口部を有する塗布ヘッドを用いて塗布液を定量吐出して一次塗布膜を形成し、高速回転にともなう遠心力で前記一次塗布膜を均一に拡散して二次塗布膜を形成する回転式塗布装置であって、前記塗布面を上にして基板を吸着して保持し、回転する回転保持手段と、前記塗布ヘッドと前記回転保持手段とを相対的に昇降する昇降手段と、前記塗布ヘッドを、前記回転保持手段の回転中心を開始位置とし、前記開口部を半径とした円形塗布面の外周を終点位置とした距離内と、前記円形塗布面の接線方向に概ね沿う位置を開始位置とし前記円形塗布面と同じ塗布面積となる環状塗布面の外周を終点位置とした距離内において、単位時間当たりの塗布有効面積が概一定になるように、順次、前記塗布ヘッドの移動速度を制御して駆動する塗布ヘッド移動手段とを備え、前記回転保持手段による基板の回転と、前記塗布ヘッドの前記移動速度による移動に伴う塗布液の定量吐出の協働とにより、前記一次塗布膜が略同じ厚さとなるように塗布することを特徴としている。

【0014】

【発明の実施の形態】以下に、本発明の好適な各実施形態について添付図面を参照して述べる。

【0015】図1は、回転式塗布装置1の全体構成を示した外観斜視図である。また、図2は、図1に図示の回転テーブル4と塗布ヘッド5の位置関係を示した平面図(a)、同正面図(b)、(c)である。

【0016】図1において、半導体基板や液晶硝子基板やプリント基板およびプラズマディスプレイ等の平面な基板3は、図示のように一對のフォーク16上に載置された状態で回転式塗布装置1と別の装置間でやり取りすることで所望の塗膜が形成される。この装置1の基部2上には、後述するモータ11の本体側が固定されている。このモータ11の出力軸か、または不図示のモータから動力を受けることで矢印方向に低速と高速とで回転駆動される回転テーブル4が装置1の上方の開口部に設けられている。この回転テーブル4は、図示のように平らな円形の吸着面を有しており、その吸着面上において真空発生装置15からバルブ14を介して真空圧を供給することで基板3を吸引保持するための無数の吸着孔4aが設けられている。

【0017】上下方向の移動については、基部2に固定される昇降モータ12の昇降動作で行なう。

【0018】以上の構成により、回転テーブル4を上方に配設された塗布ヘッド5に対して相対的に昇降するようにして、後述の塗布を行ない、塗布ヘッド5を退避させてから基板3を不図示のロボット装置のフォーク16上に載置して移載できるように構成されている。

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【0019】回転テーブル4の外周側には、回転テーブル4の高速回転にともない飛散する過剰な塗布液を飛散防止して回収処理する回収ケース9が設けられている。

【0020】一方、図示のように5個の同じ塗布ヘッド5には、塗布液供給装置6からバルブ7を介して供給される塗布液を導入する配管と、塗布直後に塗布ヘッド5内部から強制的に塗布液を吸引するサックバルブ8に接続された配管が設けられており、後述の塗布を可能にしている。以上の各バルブとモータは制御装置10に接続されており、制御装置10からの指示に基づき連動して動作できるように構成されている。

【0021】次に、図2(a)において、各塗布ヘッド5の配置と塗布原理を説明する。

【0022】第1の塗布ヘッド5Aは、一端を回転中心Oに配置しy方向に幅寸法hの開口部を配置する。この結果、回転テーブル4が矢印方向に360度分回転すると、開口部を半径とした $\pi h^2$ の面積の円形塗布面aが塗布される。

【0023】次に、開口部が円形塗布面aの接線方向に概ね沿うように配置されて円形塗布面aを内接円とし、円形塗布面aと同じ塗布面積となる第1の環状塗布面bを塗布する第2の塗布ヘッド5Bを図示のように配設する。

【0024】この第2の塗布ヘッド5Bで塗布される塗布面積は、直角三角形のピタゴラスの定理により図中の計算式から求めることができるので、円形塗布面aの面積である $\pi h^2$ と同じ面積である $\pi h^2$ の面積の第1の環状塗布面bとなる。

【0025】さらに、この第1の環状塗布面bの外周円の接線方向に開口部が概ね沿うように配置されることで、第1の環状塗布面bの外周円を内接円とした第2の環状塗布面cを塗布する第3の塗布ヘッド5Cをさらに配設する。

【0026】以下、同様に開口部が第2の環状塗布面cの外周円の接線方向に概ね沿うよう開口部が配置されることで、第2の環状塗布面cの外周円を内接円とする第3の環状塗布面dを塗布する第4の塗布ヘッド5Dと、開口部が第3の環状塗布面dの外周円の接線方向に概ね沿うように配置されることで、第3の環状塗布面dの外周円を内接円とする第4の環状塗布面意eを塗布する第5の塗布ヘッド5Eを配設する。

【0027】以上のように同じ塗布ヘッド5を図中のx軸方向に平行移動するように配置する。以上の各塗布ヘッド5A~5Eを同じ長さ同じ開口幅の定量吐出可能なスロットノズルとして塗布流体を塗布しつつ1回転させると、全て等量塗布されることになる。円盤Pに描いた円a、円環b、c、d、eには各々の塗布ヘッドで、図2(b)に示すように回転中心Oを中心とした各a、b、c、d、eの塗布面に塗布した塗布液の各平均膜厚は略等しくなる。



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【0028】この結果、比較のために破線で図示した従来の塗布ヘッド105で塗布した場合の破線図示の膜厚分布である図2(c)とは比較にならないほど平均化した平均厚みTの一次塗布膜を形成でき、その後に高速回転して均一塗膜を形成でき、しかも余剰な塗布液もきわめて少なくなる。

【0029】つまり1本の塗布面積の半径もしくは直径を有するスロットを回転中心位置にその端部もしくは中央部に配置し回転する基板に塗布させて形成したときの破線図示の膜厚分布を外周部に形成する塗膜の勾配(本

案環状円eの勾配)と等しくなるようにした場合に顕著に相違することになる。

【0030】このようにして塗布有効面を等面積に分割できるような等量吐出塗布ヘッドにより塗布することにより、概ね等厚の薄膜塗布が可能となる。また、図面では接線方向に沿うように直交して塗布ヘッドの開口部が配置される要図を示したが、y軸に対してそれぞれが傾斜するようにしても良い。

【0031】図3は、塗布ヘッド5の断面図であり、

(a)は開口部の長手方向に破断して示した横断面図であり、(b)は開口部に直交して破断して図示した縦断面図である。

【0032】図3において、各塗布ヘッド5A~5Eは図示のように3枚の異なる厚さを有するスペーサ部材17を介して不図示のボルトナットにより重ねるようにして完成される。完成後には、互いに連通するとともに上記の供給装置6とサックバルブ8に出入口が接続されるようにした流路18が形成される。この流路と18により、各塗布ヘッドの空間部19内に塗布液を同じように安定供給する。空間部19はスロット20の開口部に連通しており先端から矢印方向に同量吐出できるようにしている。

【0033】以上のように各塗布ヘッドは、幅寸法W(即ち開口部の幅寸法h)のスロットを形成するスリット20の開口部に連通し開口部の上部に開口長とほぼ同等の長さを持ち、圧力流体をスロット部に安定して送り出すことができる。このような塗布ヘッドを複数個と塗布ヘッドを適当な間隔で配置した集合塗布ヘッドとして、開閉バルブのオンオフにより塗布液の供給タイミングを制御する。また排出口にも開閉バルブを設けている。スロット間隙が十分に狭くスロット高さを十分に高くして、排出口のバルブを開き(大気圧)注入口から液を供給すると、スロット内壁抵抗により、液は貫通口を通して各塗布ヘッドの空間部19に満ち、排出口に至る。

【0034】そこで、排出口の開閉バルブを閉じると液はスロット先端部より吐出されるようになる。これを数回繰り返すと塗布ヘッド内には気泡が存在しない液で満タンになった状態を作り出すことができる。そこで、供給口の開閉バルブを閉じ、排出口の開閉バルブの先に設

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けたサックバルブにより液を吸引すると、吐出開口部先端部の液はスロット内に引き込むことができるので、直後に排出口の開閉バルブを閉じる。この状態になると塗布作業を開始できる待機状態となる。なお、供給口への流体供給は一定の圧力で供給されるものであれば、いかなる手段を用いても良い。

【0035】このような構成の塗布ヘッドの開口部の先端部と回転する基板の塗布面との間隙を所定値にするために相対的に昇降させつつ塗布を行なうが、その昇降タイミングは塗布ヘッドの供給バルブを開き、塗布ヘッド先端に塗布液が滲み出て小さな液玉を連続的に形成した直後であればより良い。

【0036】このようにして基板3が360度回転以上するまで塗布を行い、定められた回転角度に達すると液注入口の手前に設けた開閉バルブ7を閉じ、また、液排出口から液の吸引を行ない、昇降手段にて塗布ヘッドもしくは塗布される基板3を昇降移動させる。このようにして形成された塗布面は塗布ヘッドの設置数に見合う小さな波紋波の塗膜が形成されることになり、各波紋状の塗布面間の平均膜厚Tは同じ厚みとなり、塗布有効面のほぼ全域が塗布液で濡らされた状態となった一次塗布膜を得ることができる。この後に、基板を所定時間の高速回転させるように回転テーブル4の回転数を制御することで所望する均一膜厚の二次塗布膜を得ることができる。

【0037】ここで、以上のように集合塗布ヘッドにおける各塗布ヘッドの開口部の幅寸法を半径と同じように設定することにより、従来のように回転テーブルの直径分の開口部を有する塗布ヘッドの製造に比べて、スリット開口部の先端の直線性を確保する部分が短くなるので、製造工程が非常に簡単になる。

【0038】図4(a)~(e)は、塗布ヘッドの配置図である。本図において、上述したものは、中央部に位置する開口部の一端を回転中心に位置決めして、他の一端が描く円に対して概外接するように順次スロットの開口部を配置するようにしたもので、中央部のスロットの開口部の幅寸法hは描く円の半径であり、理論上では上記のように波紋状態で一次塗膜を形成できるものであった。図4(b)は、各塗布ヘッド5の開口部の幅にh1分余分な大きな開口幅を設けたものであって、このようにすることで波紋の重なり部分をより均一にできる。また、図4(c)は、開口部の幅寸法が2hにしたものであり、中央部スロット開口の中心を回転中心に配置すると描く円の直径となるようにしている。また、図4

(d)は、塗布ヘッドの中央部のスロット開口部の幅寸法を他の塗布ヘッドの2倍である2hとし、回転中心点を中心にして点対称位置に幅寸法hの開口部の塗布ヘッドを2組分配置したものである。そして、図4(e)は、塗布ヘッドの中央部のスロット開口部の幅寸法を他の塗布ヘッドの2倍である2hとし、この中心の塗布ヘ

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ッドの開口部の線対称位置に幅寸法 $h$ の開口部の塗布ヘッドを2組分配置したものである。

【0039】図4(d)、(e)に図示のように塗布ヘッドを配置することで、図4(a)～(c)において塗布時の回転角度が360度以上必要であったものが、180度以上であれば良いことになる。

【0040】なお、以上のような構成にした塗布ヘッドの中央に位置するスロット開口部は他のスロット開口部と必ずしも平行に配置せず角度を設けたり、直交させても何ら原理に変わらないことはいうまでもない。

【0041】次に、図5(a)は、図示のような矩形の基板3に対して、図5で示した塗布ヘッド5で塗布を行なったときの各塗布ヘッドが描く塗布円と回転する基板の状態を説明した図である。図5(b)は、塗布ヘッド5Dおよび塗布ヘッド5Eを取り去り塗布ヘッド5C延長し、また図5(c)は塗布ヘッド5Cを2倍に延長した図である。

【0042】図5(a)と図5(c)で1サイクル塗布動作に消費する液吐出量を比較すると、図5(a)の塗布量を「5」としたとき、図5(c)では「4」となる。また図5(c)の塗布ヘッド5Cは環状塗布面eの外に一部をはみ出しているので、この環状塗布円e内に収めると図5(b)に示すように「4」以下の塗布量となる。図5(b)の塗布ヘッド5Cは環状円c、d、eに塗布することになるが、円形塗布面aおよび環状塗布円bにおける平均塗布膜厚は等しく環状塗布面cの平均膜厚も一部若干厚め気味であるがほぼ環状塗布面a、bに等しくなる。

【0043】環状塗布面dおよびcでは塗布ヘッド5Cの $\delta$ 、 $\eta$ 分の開口部で基板に塗布を行なうことになるが、基板3上における塗布有効面積は環状塗布面dの数分の1であり、環状塗布面eの数十分の1となる。即ち、図5(b)の例に示したように塗布ヘッド5Cの長さを適当な長さにすることで、液効率の高い塗布が実現できることになる。

【0044】また、図5(b)の例では塗布ヘッド5Cの一端を延長したが、基板3のサイズや開口部の長さ次第では塗布ヘッド5Cの両端を適宜延長したり塗布ヘッド5Cの配置を塗布ヘッド5B方向に寄せて、外周部の塗布膜を厚く塗り、高速回転で拡散させることができる。また、塗布ヘッド5の数や開口部の幅寸法や液供給圧力等は、基板の形状、サイズ、所望膜の厚み、塗布対象液の粘性等から適宜選定されることはいうまでもない。

【0045】塗布ヘッド5の開口長さは、図6(a)の横断面図と縦断面図(b)に図示のように、2つの壁面間にシム21を挟みボルト22で締め付けて塗布ヘッド5を形成するようにすれば、シム交換で開口長および開口位置、さらに開口幅 $W$ を容易に変更することが可能である。もちろん塗布ヘッドを構成する全ての塗布ヘッド

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のシムは等厚であることはいうまでもない。

【0046】次に、図7は、第2実施形態の回転式塗布装置の動作原理図を示した平面図である。また、図8は塗布ヘッドの動きを示した正面図であって、待機位置(a)、塗布開始位置(b)及び基板取り出し位置を示した図である。

【0047】先ず図8において既に説明済みの構成部品については同様の符号を附して説明を割愛すると、塗布ヘッド5は、1つのみが図8において不図示のヘッド移動昇降機構に搭載されている。この塗布ヘッド5には距離センサ26が固定されており、基板3と開口部の間の距離を測定しつつ移動して、図8に図示のように基板3上への移動に伴う塗布が行なえるように構成されている。また、上述のモータ11の出力軸となるボールスプライン軸30(破線図示)の上端に固定されている回転テーブル4は、図示のように昇降モータ12への通電に伴い上方に移動されるとともに、図8(c)の位置において不図示のロボット装置の一对のフォーク16が回転テーブル4の外周面の側面であって基板3の下方に潜入するようにして、基板3を載置できるように構成されている。

【0048】図7において、上述した各塗布ヘッド5の開口部の幅寸法は等しく塗布ヘッド5Aの一端が回転中心に配置され他端が円形塗布面aの外周面まで塗布するようにしたものであったが、このときの、各塗布ヘッド5A～5Eの間隔の比は塗布ヘッド5A、5B間の長さABである $h$ を「1」としたとき直角三角形のピタゴラスの定理から次のようになる。

【0049】 $AB : BC : CD : DE : DF : \dots = 1 : \sqrt{2} - 1 : \sqrt{3} - \sqrt{2} : \sqrt{4} - \sqrt{3} : \sqrt{5} - \sqrt{4} : \dots : \sqrt{n} - \sqrt{n-1}$

したがって、これらの塗布ヘッド間の各距離AB、BC、CD、DE、DF間を塗布ヘッド5が移動する時間が等しくなるように移動速度制御を行なえば、単位時間当たりの塗布ヘッドの吐出量および基板回転数が一定である条件下において、塗布面a、b、c、d、…のほぼ全域の塗布膜厚は一定になることになる。そこで、図7において破線で図示される個所を基点及び終点とするように同じ塗布ヘッド5の移動制御を行なうようにしている。ただし、塗布開始点と完了点近傍では多少ばらつくことになる。

【0050】以上の塗布動作には2通りあり、回転中央部から塗布を開始する方法と外周部から開始する方法がある。回転中央部から開始する場合には、図7(b)に図示のように低速回転する基板3の上方待機位置P1から、液吐出を開始しつつ塗布ヘッドを下降させつつ高速で斜めに移動し回転中心の手前位置P2で塗布液を基板3の表面にランディングさせて、回転中心位置から終点まで減速制御を行ない塗布する。終点位置は基板内でも基板3の外側でも良い。

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【0051】また、基板3の外周側から開始する場合は、図7(a)に示したE位置から開始し、回転している基板表面と塗布ヘッド先端を所定の間隙に設定し、塗布液吐出を開始して、回転中心に向かって移動する方法である。この開始時に塗布ヘッドは停止状態となっており、徐々に加速し、回転中心または中心をオーバーした位置で塗布ヘッドを上昇させるように駆動される。

【0052】このような回転する基板に加減速の速度制御を行ないながら移動塗布を開始すると、上記のいずれの方法においても開始部および終点を除きほぼ均一な一次塗布を行なうことが可能となる。この後に、高速回転させることで所望する均一な二次塗膜を得ることができる。

【0053】以上のように塗布することで、余剰な塗布液は不要となり液効率の高い省液塗布が実現できることになる。塗布ヘッド5の長さおよび塗布ヘッド端部の位置は例えば図5に示したように適宜選定すれば良く、従来の回転式塗布装置の塗布ヘッドより低コストで製造できる短尺塗布ヘッドの使用が可能となる。また、この方法は円形基板の省液塗布法として有効であるばかりでなく、矩形基板であっても、回転外周部近傍の速度を適宜制御することで省液効果が高くなることはいうまでもない。

【0054】ここで、塗布ヘッドの先端開口部と基板の塗布表面の間隙は、薄膜塗布を追求すればするほど重要な要素となる。数 $\mu\text{m}$ 厚のウェット膜塗布を行なうときの間隙は数十 $\mu\text{m}$ ±20 $\mu\text{m}$ 程度がよく、それ以下になると塗布ヘッド先端と基板表面に形成される液溜りで塗布ヘッドの先端部以外が汚損される可能性が高くなり、連続生産する作業において、その汚損液が次の対象物を汚損する虞がある。

【0055】また、それ以上になると塗布先端から基板表面に至るまでのカーテン状の流体を表面張力で塗布ヘッド開口長全域に連続して形成することが難しくなり一部が切れる可能性が高くなる。さらに基板3の板厚は10~20 $\mu\text{m}$ ほどロットにより異なる。このことから、上述のように距離センサ26でモニターして基板表面の高さを検出し適切な間隙を基板1枚毎に設定することは薄膜塗布を行なうときに、一次塗布膜の品質と液効率を向上させる上で重要となる。

【0056】以上のように使用される塗布ヘッドは、上記のようにスリット状の開口部から吐出するに留まらず、図9(a)から(c)に図示のように開口形状は多数の細孔23を略直線状に設けたノズルであってもよい。すなわち、塗布ヘッドから流体を吐出する際の流体の状態を説明すると、塗布ヘッドノズル内に液先端を収納した状態の流体を吐出すると、吐出流体は先ず塗布ヘッド先端に微小な半球状の液玉を形成することになる。この半球状の液玉を開口部全域にわたり形成した後に、ヘッド先端と基板の間隔を所定の値に短縮すると液玉は

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つぶれて、塗布ヘッド開口全長に連続した液ダマリの膜を形成することになる。この状態から塗布ヘッドもしくは基板を相対的に走行させると、つぶされた液玉(厚塗りの余剰液)は走行動作で引伸ばされることになる。このようにして先端部に形成される液玉は直径0.数mm以下の小玉をほぼ等間隔に並べることができたとき塗布品質は高いことが確認されている。

【0057】図9に図示の細孔ノズルについても同様であり、流体吐出時には多数のピンホール先端に半球状の液玉を多数形成し、基板表面と所定の間隙になるようにすると、連続した液溜りを開口部全長に渡り形成できるようになる。このような塗布ヘッドノズルの構造において、ピンホールの細孔23を定ピッチ配列し、図9

(a)に図示のように細孔を先端まで設けるか、図9

(b)に図示のように端部に更に細状の連続した塗布ヘッドを設けるようにしても良い。

【0058】このような細孔形状にすると、一体のブロック加工で吐出部を作成できることから、製作コストを減ずることができ、取り扱いを容易にできる効果がある。

【0059】ブロックは必ずしも一体でなく2分割したもので良い。また細孔形状は丸穴に限らず角穴でも良く、同一形状の細孔であれば形状を問わない。

【0060】以上のように、モータを使用することで低速回転する基板に少ない塗布液で概ね均一で基板中央部が山形にならない一次塗膜をすばやく得るとともに、低騒音、低振動の省液塗膜を得ることができさらなる品質向上を実現できる。

【0061】

【発明の効果】以上説明したように、本発明によれば、塗布ヘッドを用いて一次塗布膜を形成した後に、高速回転にともなう遠心力により二次塗布膜を形成する回転式塗布装置において、二次塗布膜に大きな影響を与える一次塗布膜を塗布するときに、基板回転の中央部が山形になったり、不均一な状態となることがなく、しかもより少ない塗布液で塗布することができる回転式塗布装置を提供することができる。

【図面の簡単な説明】

【図1】第1の実施形態の回転式塗布装置の外観斜視図である。

【図2】(a)図1の塗布動作原理を示す平面図、(b)図2(a)の正面図、(c)従来の塗膜との比較を示した正面図である。

【図3】(a)塗布ヘッドの横断面図、(b)塗布ヘッドの縦断面図である。

【図4】(a)~(e)別実施形態の塗布動作原理を示す平面図である。

【図5】(a)~(c)別実施形態の塗布動作原理を示す平面図である。

【図6】(a)塗布ヘッドの横断面図、(b)塗布ヘッ

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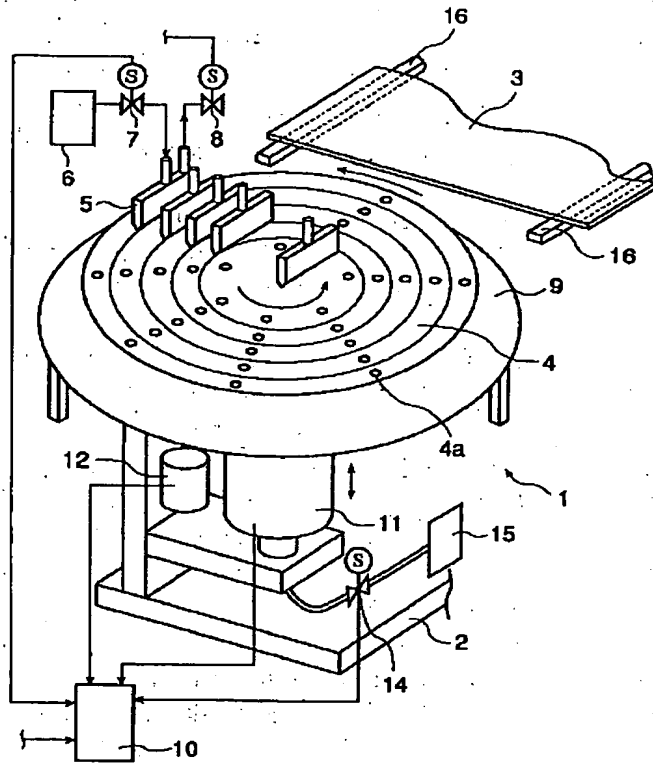
ドの縦断面図である。

【図7】 (a) 第2の実施形態の回転式塗布装置の塗布動作原理を示す平面図、(b) 塗布ヘッドの動作状態図である。

【図8】 (a) ~ (c) 塗布装置の動作説明の正面図である。

【図9】 (a) 塗布ヘッドの横断面図、(b) 塗布ヘッ

【図1】



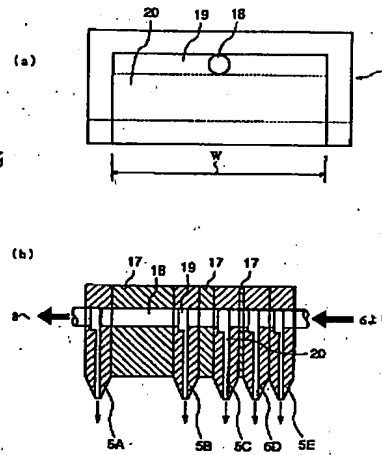
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ドの縦断面図である。

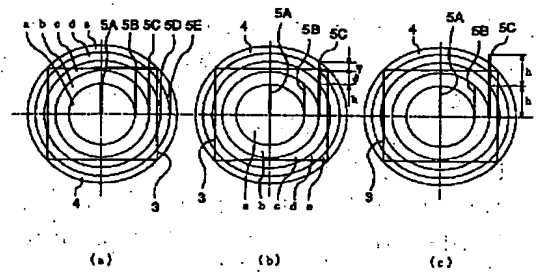
【符号の説明】

- 1 回転式塗布装置
- 2 基部
- 3 基板
- 4 回転テーブル
- 5 塗布ヘッド

【図3】



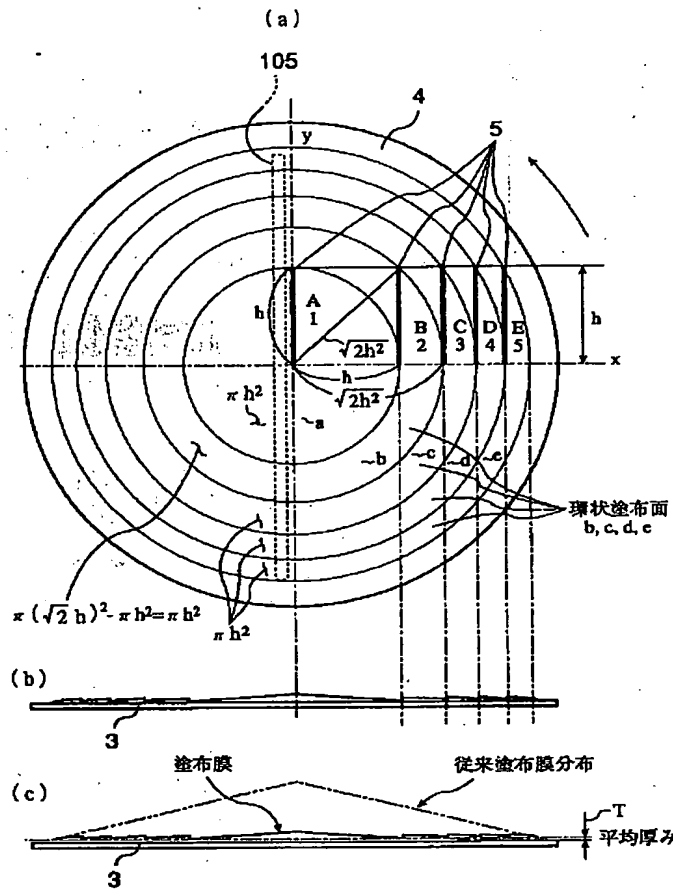
【図5】



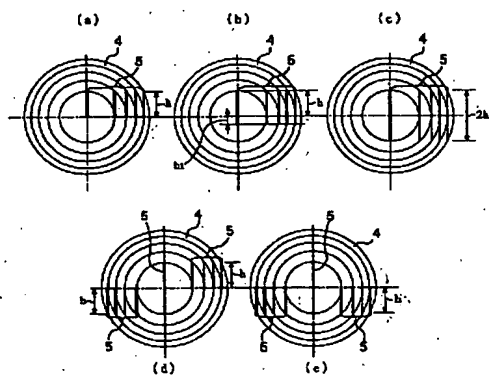
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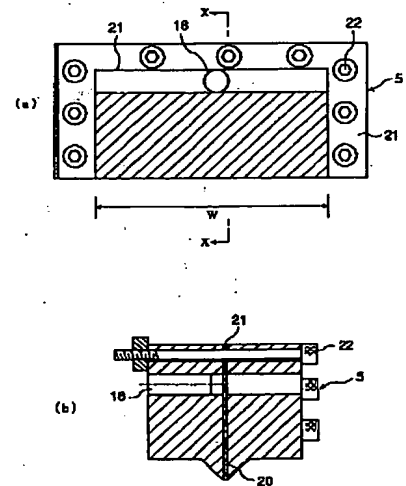
【図 2】



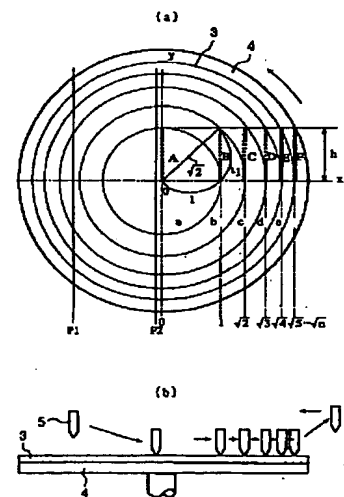
【図 4】



【図 6】



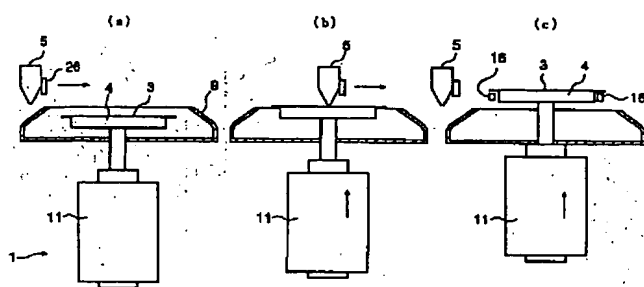
【図 7】



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【図8】



【図9】

